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ANALYTICAL STUDIES OF GROUP BEHAVIOR IN BIRDS[1]

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The bird flock as a social organization is again receiving a part of the attention it deserves. With increase in facility in marking individuals, there has come new and valuable information regarding some aspects of the intimate social structure of bird groups. Some of the earlier work was reviewed by Allee (1931, 1934); the most spectacular of the modern trends was initiated by Schjelderup-Ebbe who has recently summarized his own studies (1935). In this latest summary, Schjelderup-Ebbe says (p. 949), "One of the points which the recognition of each individual bird in the flock of the same species makes it possible to observe is that *there exists among birds a definite order of precedence or social distinctions.*[2] The precedence in rank proved to be founded upon certain *conditions of despotism.* Between any two birds of each species, in a large number of species examined, one individual *invariably* had precedence over the other . . ." Schjelderup-Ebbe records that he has observed such despotism in over fifty species of birds including the common chicken, a common sparrow, various ducks, geese, pheasants, cockatoos, parrots, various tits, and the common caged canary.

Stimulated by Schjelderup-Ebbe's early observations, for several years at Chicago, we have been accumulating data concerning the social hierarchy in some few species of birds. Our experience with the common chicken (Masure and Allee, 1934a) is similar to that of Schjelderup-Ebbe, Murchison, and other observers. With the other birds, our observations differ significantly.

Masure and I found first with pigeons that the position in the social order is not so firmly fixed that one bird of a given contact pair always is dominant and the other always gives way. Rather we found that individual relationships in the flocks of pigeons which we

[1]This report is a review of studies published or to be published in detail elsewhere.

[2]All italics as in the original.

studied were give and take affairs. To be sure one bird of any two usually dominated more than it retreated. In a flock of seven male pigeons, in only two of the twenty-one possible pairs did the same bird win all the observed contact reactions. In the other nineteen pairs, the loser, on the average, won twenty-three and lost forty of the observed pair contacts.

In the similar group of sex segregated female pigeons, no single bird dominated any other individual in all their observed pair contacts; rather the loser won an average of twenty-five and lost an average of forty-five such encounters. One bird, *RY*, stood at the bottom of the social order at first and came to dominate the whole female flock in the end. Even in the twenty-eight days during which we studied her while she occupied the dominant position, she lost fifty-eight contact reactions while winning 329. All the other members of the flock, except one, won over her during her period of dominance; one of them as many as twenty-two times that we witnessed.

There is also a place factor in the dominant-subordinate relationship. Among these female pigeons, at one time, *BB* dominated at the entrance to the roost, while *BY* won the majority of all her contacts on the ground.

With shell parrakeets, Masure and I (1934b) found a similar sort of flock organization except that among the female flock of seven, during our somewhat brief period of observations, there were six of the twenty-one contact pairs in which one female had been regularly submissive or had engaged in "no decision" contacts; among the males there were four such cases again out of twenty-one possible pairs. Of the others, the loser among the females on the average, won five and lost twenty-nine of the observed decisive contacts. The corresponding figures among the sex segregated flock of males are six and twenty-seven, respectively.

Since these data were published, Miss Mary Bennett has observed the same win-and-lose sort of organization among ring doves, and Mr. Hurst Shoemaker has made extensive observations with canaries and more incidental ones with a flock composed of five White-throated and one White-crowned Sparrow. Among the canaries, he finds the give-and-take relationship: with the sparrows, there is apparently a greater fixity, but even with them a reversal has been observed in the same hour's observation and without an unusually violent struggle.

In all these birds in which this now-one-wins-now-the-other reaction takes place, there is no evidence that the reversals are unusual reactions as they undoubtedly are among chickens. In the same hour,

one canary or pigeon or ring dove may dominate in a given contact and the other of that particular contact pair may dominate at their very next meeting.

The picture that emerges is one of a flock organized into a social hierarchy which, however, is not necessarily so hard and fast as that of chickens. In the long run in such groups, one becomes fairly sure which of two given individuals will dominate in the larger number of their contacts, but the result of any one meeting is not predictable with certainty.

Putting the matter somewhat facetiously, all of Schjelderup-Ebbe's birds and American chickens as well appear to have the sort of "line organization", which is characteristic of a military system or of a Fascist or Nazi state while the birds we have studied, chickens excepted, have a more democratic organization. The sort of hierarchy found among chickens may be characterized as being based on an almost absolute peck-right while that we have seen in pigeons, ring doves, canaries, and perhaps in sparrows, is based on what may be called a peck-dominance.

With many birds there is a definite social prestige related to sex. The usual report is that the more showy or larger sex is dominant. With the shell parrakeets which we have tested, the females are distinctly dominant except during the breeding season when the dominance shifts to the other sex. In shell parrakeets the two sexes are closely similar in coloration and size. The males tend to be less shy in the presence of an observer but in a mixed flock they are clearly dominated much of the year by the females. Even the low ranking birds in a homosexual flock dominated the high ranking males when placed with them.

It has been reported by others (Katz and Toll, 1923) that in chickens there is a positive correlation between ability to learn and social position; with the parrakeets, Masure and I found no such correlation. This is one of the points that Mr. Shoemaker is now testing with canaries.

Masure and Allee (1934b) suggested that high rank in the social order could easily have survival value during times of food shortage, a suggestion which needs to be tested by exact observation. Murchison (1935d) subjected a flock of chickens to mild starvation and found that the dominant roosters lost more weight than those lower in the social scale and that, in fact, loss of weight was directly proportional to social position. This is explicable in terms of the behavior differences he found to be associated with social position, a matter which will be examined shortly.

It would be extremely interesting and important to make further analyses of the underlying physiology of the social hierarchy. Such experiments might well proceed along two different lines. In the first place, using a white breed, such as the white leghorn chicken, one could alter coloration of birds with known social status and ascertain whether color is an important recognition mark in these social hierarchies. Such experiments would have immediate significance in relation to the whole question of recognition color markings. Along the same line of experimentation, contour lines could also be modified by plucking or cutting feathers. e. g., or by some other method. and test thereby the importance of this factor in social recognition.

More significant investigation would endeavor to alter experimentally the physiological state of selected birds of known status in the social group. The injection of sex hormones, e. g., and many of the other devices of the students of sex physiology. would give an excellent chance for testing the social effects of these active physiological agents. The possibilities of experimental work along this line are almost as varied as the probable results are important and fascinating. Preliminary experiments indicate that positive results may be expected.

Another aspect of this problem has been somewhat investigated already. This is concerned with the effect. direct social order contacts aside, of the presence of other individuals on the behavior of any given member of the flock. With chickens, Murchison has recently reported a series of studies covering certain phases of these reactions. When released from behind glass doors into a narrow runway, cocks will run toward each other; the one higher in the social order will run the greater distance (1935a). When two cocks from the same flock are confined in wire cages some six feet apart, and a third member of the flock is released into the enclosure containing the cages under the conditions of the experiment. the free bird, if a male, goes toward the caged cock that is lower in the social hierarchy; if a female, it goes toward the cock that is higher in the hierarchy (1935b).

Three of the six cocks in the one flock Murchison studied did not exhibit primary sexual behavior; of the other three, the number of treadings, other conditions being similar, were in order of the relative dominance of the cock, with the most dominant bird treading pullets most frequently. Also the dominant female was most trod of the pullets and the number of treadings of the other females was in direct relation to their position in the social scale; the pullet lowest in the social hierarchy received the least sexual attention (1935c). These last observations are in accordance with the findings of Masure and

Allee that birds high in the social scale have more contact reactions per unit of time than do those low in the social order in the same flock.

Another type of interaction between individual birds has been tested by Allee and Masure (1936). The fact that shell parrakeets are closely flocking species led us to an extended study of the rate of learning of these birds in a simple two-alley "problem" box when isolated and when paired. From observations on other animals it seemed likely that the parrakeets might learn more rapidly if paired, but this expectation was not realized.

Both isolated and paired parrakeets showed rapid improvement in speed of reaction and in reduction of errors with repeated trials in the simple "problem" box which was used. Under both conditions, the period of most rapid learning lasted from ten to twelve days, after which there was a long, slow improvement for weeks until, in the majority of cases, the animals came to run rapidly and surely through the maze. The standard criterion of excellence set for the birds was the running of five trials per day for two successive days without errors. Often the birds would run through the maze in a mean time of five seconds or even less, per trial when on their first performance, they would take on the order of 200 seconds or more.

Throughout these tests, the paired birds showed significantly slower reaction times and tended to make more errors than isolated birds of the same stock and with similar treatment. Although paired parrakeets can become as well trained as their isolated fellows, the training period usually takes longer and final performance tends to be more erratic.

Parrakeets caged in pairs and trained alone show learning curves very similar to those given by others caged as well as trained singly. When paired and isolated birds which had become well trained to go toward green rather than toward red light had their grouping reversed, the newly isolated birds showed less disturbance than the newly paired individuals. When birds so trained to respond to the green of the green-red signal were rearranged with the paired birds isolated and the formerly isolated birds paired, and then trained to go toward blue in a blue-yellow signal, the change in signal appeared to be more disturbing than the change in social relationship.

Incidentally, some of these parrakeets retained marked effects of their training for a period of from six to eight months during which time they had passed through a breeding season in an outdoor aviary. No attempt was made to determine the relative retention by paired and by isolated birds.

The two lots of parrakeets whose training was continued into the spring season exhibited an unexplained disturbance in their maze performance probably associated with a foreshadowing of the breeding period. Both isolated and paired birds showed the disturbance; the paired birds more than the isolated ones. Throughout the work, however, there was no evidence that the hetcrosexual pairs behaved differently in the maze, from the homosexual pairs.

There was a decided tendency for birds of a pair to give similar reaction times and to make the same errors in any one run through the maze. The presence of the second individual was often a disturbing factor; apparently it introduced a sort of distraction such as has usually been found in similar experiments with other animals.

Summary

1. The social order among chickens and perhaps in the observed sparrows is of the relatively firmly fixed, despotic sort originally described by Schjeldcrup-Ebbe.

2. In pigeons, shell parrakeets, ring doves, and canaries, the social order, while distinctly recognizable, is less firmly fixed; subordinate individuals normally "win" a minority of their pair contacts.

3. Promising lines of investigation of intra-flock relationships are suggested.

4. Within the flock, individual members react on others in ways not directly concerned with the establishing and maintaining of a social hierarchy. These reactions include differential behavior to the various individuals in the flock, as analyzed by Murchison for chickens, and the distracting effects that result from the presence of a second shell parrakeet during training in running a simple maze.

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NOTES ON THE HORNED LARKS OF THE CENTRAL OHIO REGION

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The status of the various races of the Horned Lark (*Otocoris alpestris*) that occur in Ohio has received little attention from Ohio ornithologists. The following notes are based upon observations and collections made during the course of more than 1000 field trips in the central part of the state over a twelve-year period from 1922 to 1933, chiefly near Columbus and at Buckeye Lake, but also at numerous other localities in the counties of Union, Delaware, Franklin, Licking, Fairfield, and Pickaway, all in the till plains province of the state. As a matter of convenience we have referred to this area as "Central Ohio", but such generalizations as occur in these notes are not intended to apply beyond the limits outlined above. Particular attention was given to the winter population in an effort to determine approximately the relative abundance of the three races, *Otocoris alpestris alpestris*, *O. a. praticola*, and *O. a. hoyti*.

Under favorable conditions of light the great majority of individuals may be accurately identified in the field. Many such identifications have been checked by collecting. During the winter the gregarious habits of the Horned Lark make possible the close comparison of individuals, and the slight differences in size and color that characterize the different races become relatively conspicuous.

The Prairie Horned Lark (*Otocoris alpestris praticola*) is a moderately common although somewhat local breeding bird in central